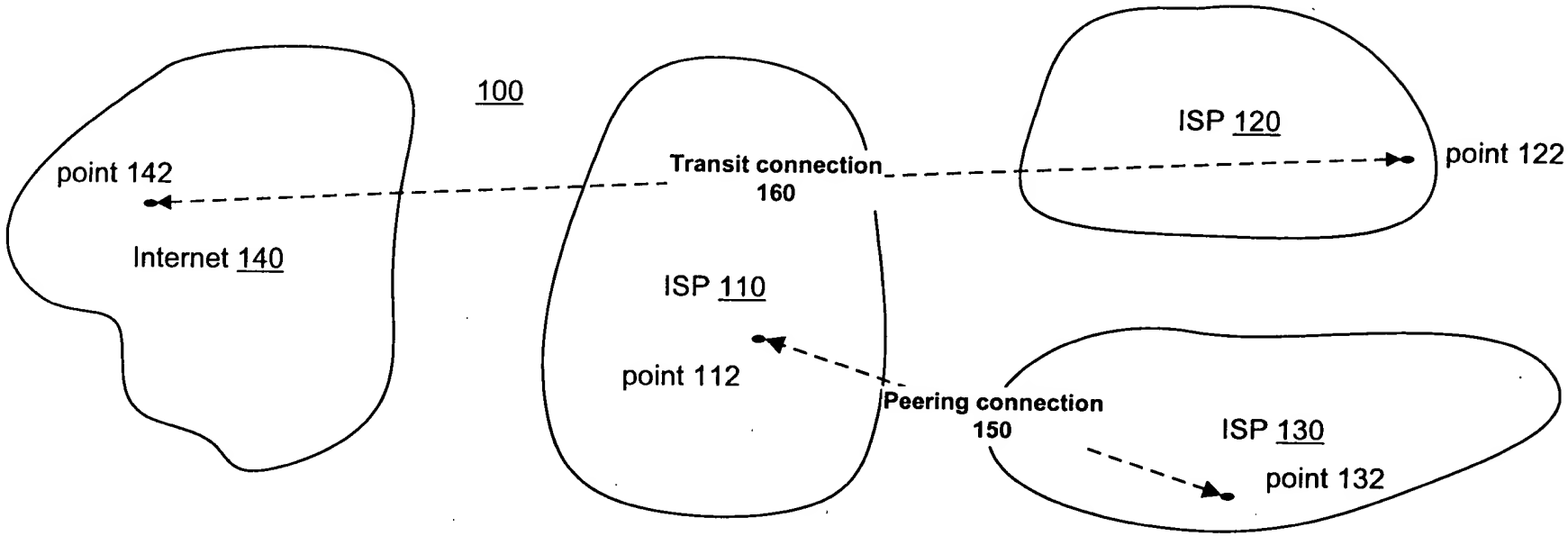

100
point 142
Internet 140
Transit connection
160
ISP 120
point 122
ISP 110
point 112
Peering connection
150
ISP 130
point 132

Figure 1A

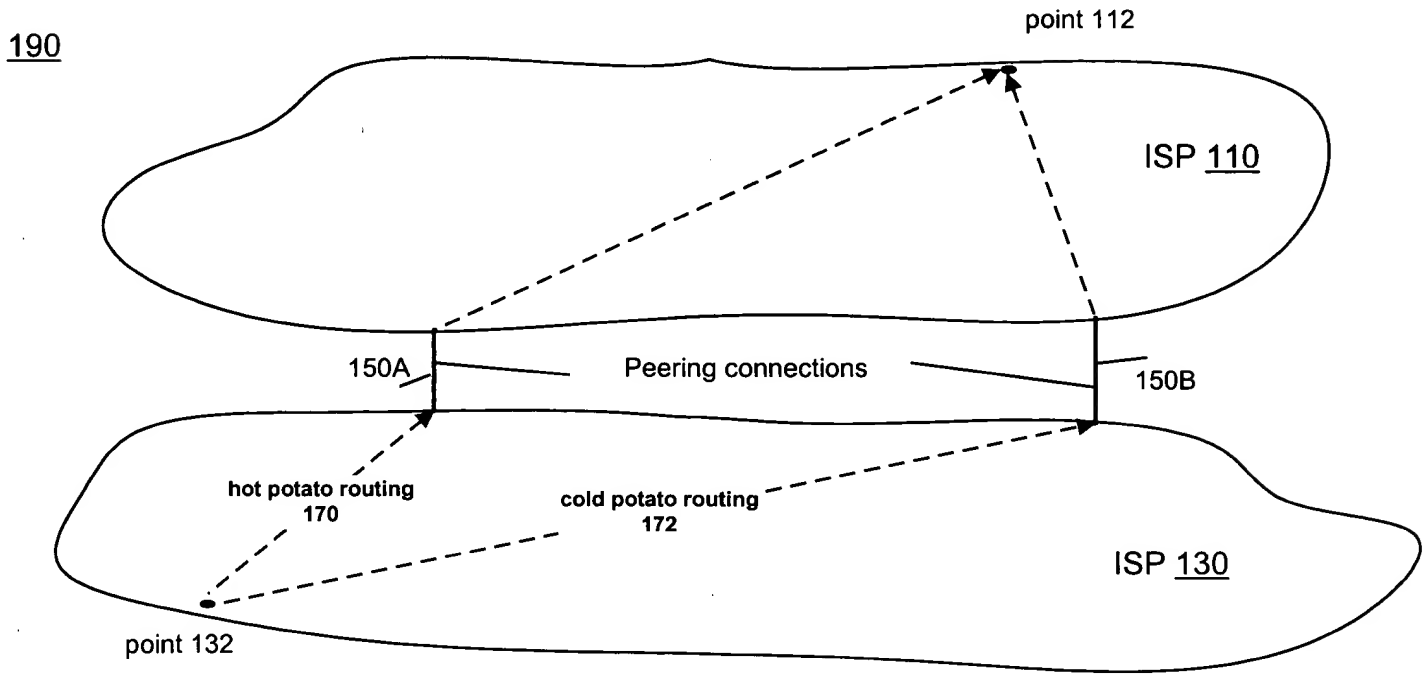

190
point 112
ISP 110
150A
Peering connections
150B
hot potato routing
170
cold potato routing
172
ISP 130
point 132

Figure 1B

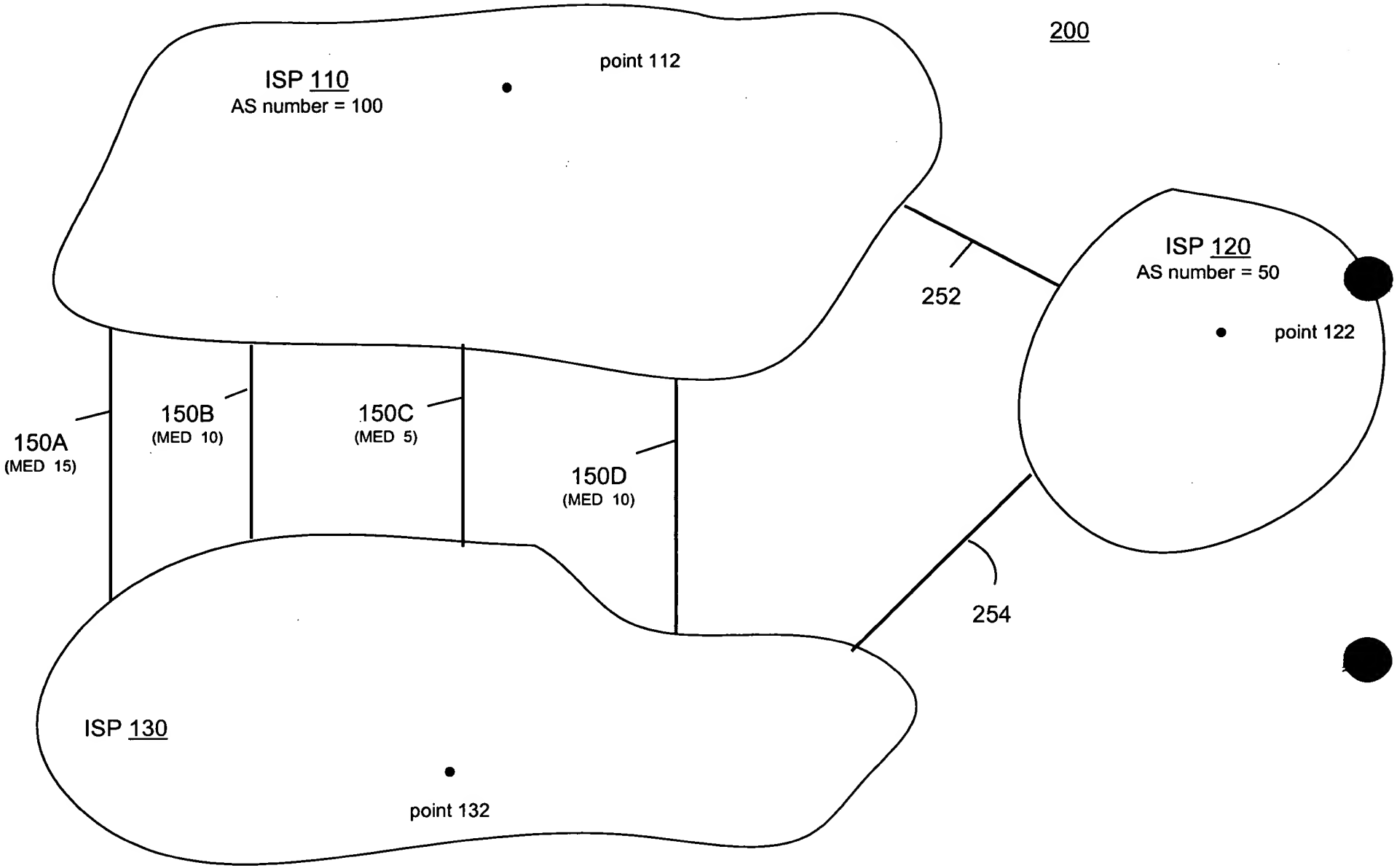
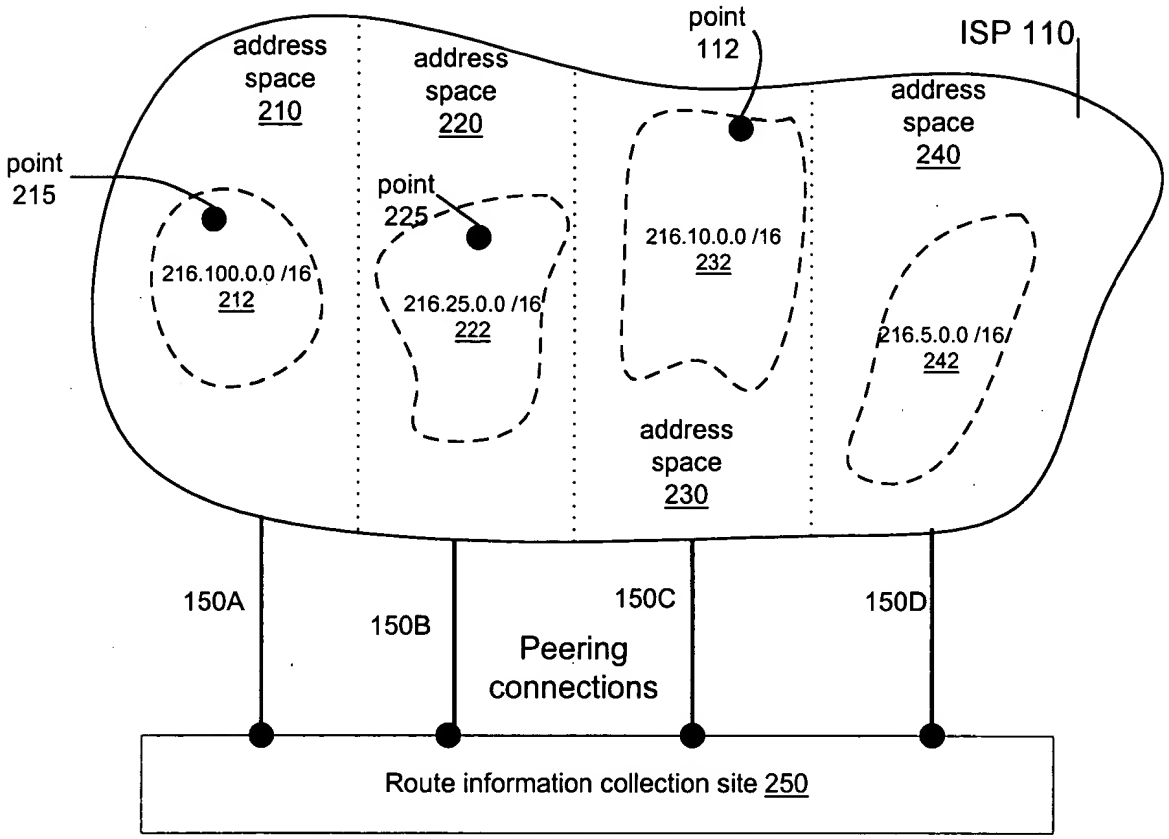

200
ISP 110
AS number = 100
point 112
ISP 120
AS number = 50
point 122
252
150A
(MED 15)
150B
(MED 10)
150C
(MED 5)
150D
(MED 10)
254
ISP 130
point 132

Figure 2A

Figure 2B



IP ADDRESS	PREFIX	ROUTE INTERFACE	% OF TRAFFIC SEEN BY SITE 250
216.0.0.0	/8	150A	50
216.0.0.0	/8	150B	50
216.0.0.0	/8	150C	0
216.0.0.0	/8	150D	0

IP ADDRESS	PREFIX	ROUTE INTERFACE	% OF TRAFFIC SEEN BY SITE 250
216.100.0.0	/16	150A	100
216.25.0.0	/16	150B	100
216.10.0.0	/16	150C	0
216.5.0.0	/16	150D	0

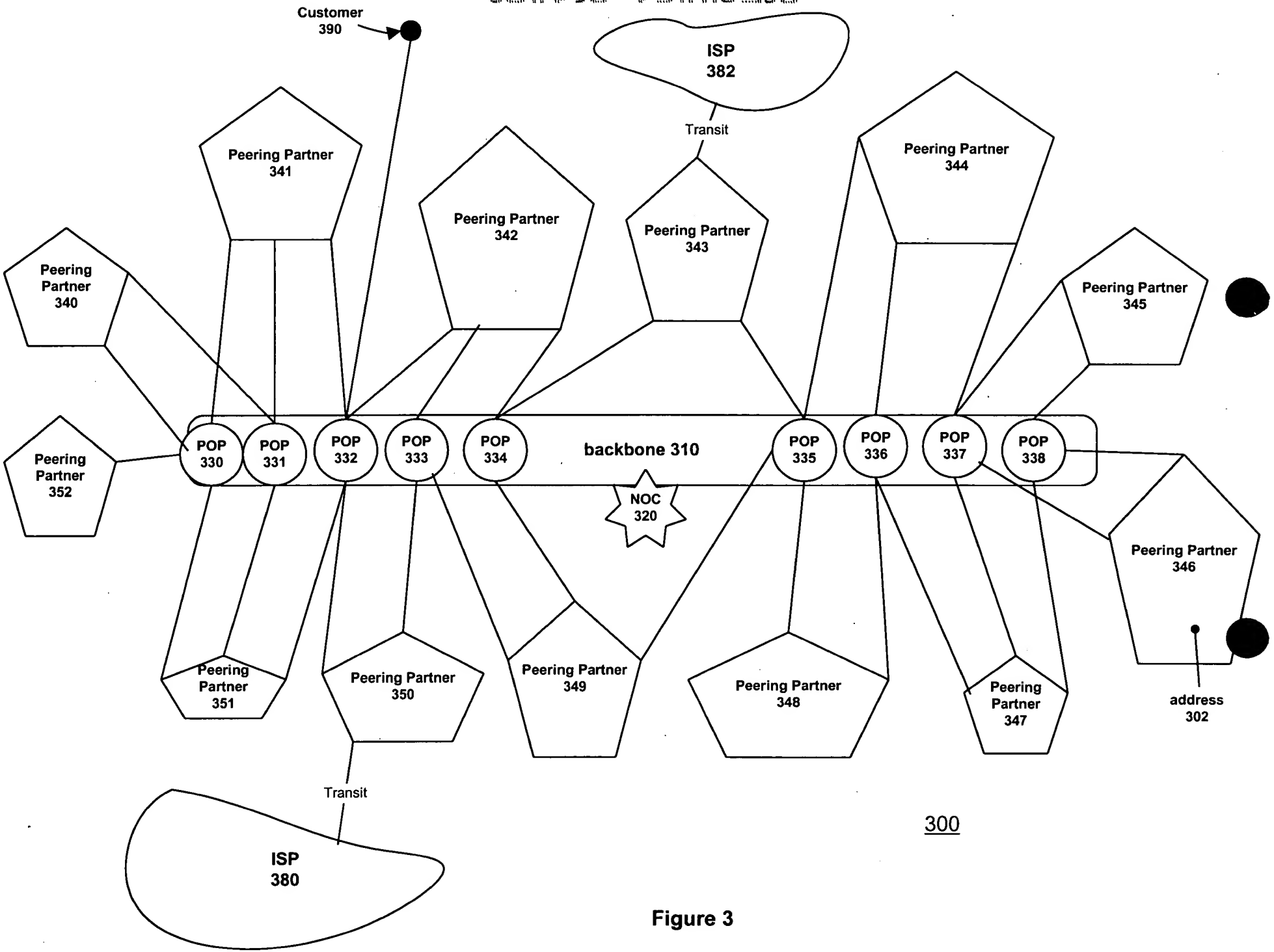

Customer
390
ISP
382
Transit
Peering Partner
341
Peering Partner
342
Peering Partner
343
Peering Partner
344
Peering Partner
345
Peering
Partner
340
Peering
Partner
352
POP
330
POP
331
POP
332
POP
333
POP
334
backbone 310
POP
335
POP
336
POP
337
POP
338
NOC
320
Peering Partner
346
address
302
Peering
Partner
351
Peering Partner
350
Peering Partner
349
Peering Partner
348
Peering
Partner
347
Transit
ISP
380
300

Figure 3

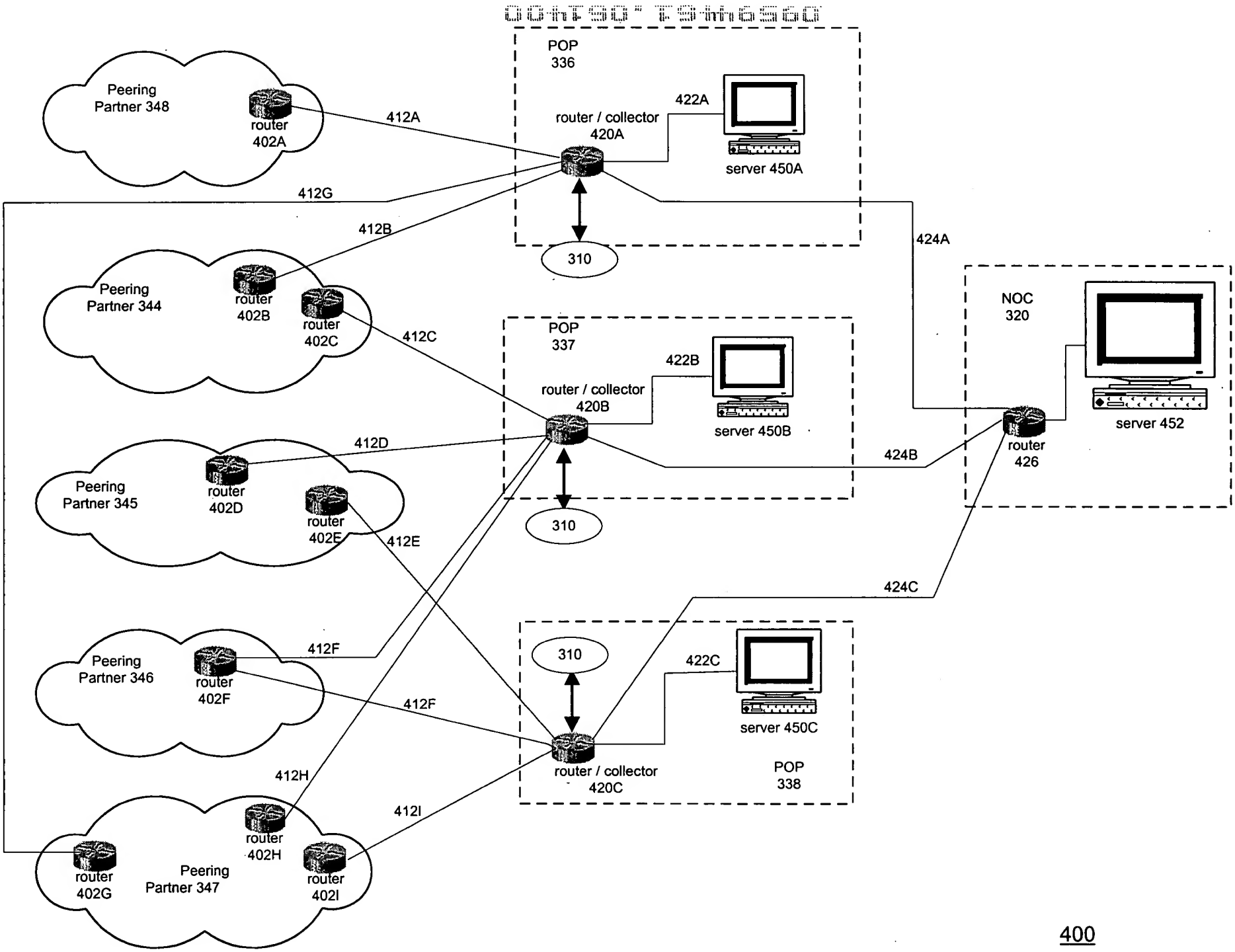

POP
336
Peering
Partner 348
router
402A
412A
router / collector
420A
422A
server 450A
412G
412B
424A
310
Peering
Partner 344
router
402B
router
402C
412C
POP
337
422B
router / collector
420B
server 450B
NOC
320
server 452
router
426
412D
424B
Peering
Partner 345
router
402D
router
402E
412E
310
424C
Peering
Partner 346
router
402F
412F
412F
310
422C
server 450C
router / collector
420C
POP
338
412H
412I
router
402H
router
402G
Peering
Partner 347
router
402I
400

Figure 4

IP Statistics Data Table 500

IP Address	Mask	Prefix length	Exchange ID	Interface number	Packet count	Byte count	Strength	Pointer to associated route entry
140.150.0.0	11111111.11111111.11110000.0000	/20	POP 330	5	10000			
140.150.16.0	11111111.11111111.11110000.0000	/20	POP 330	5	10			
140.150.16.0	11111111.11111111.11110000.0000	/20	POP 330	6	100			
140.150.32.0	11111111.11111111.11110000.0000	/20	POP 330	5	10			
140.150.32.0	11111111.11111111.11110000.0000	/20	POP 330	7	100			

Figure 5A

Route Entry Table 510

IP Address	Mask	Prefix length	Exchange ID	Interface number	Strength	Next hop	Peer ID	AS Path	MED	Status flags	Packet count	Byte count
140.150.0.0	11111111.11111111.00000000.00000000	/16	POP 330	5		140.100.1.1	1	100	5		10020	
140.150.0.0	11111111.11111111.00000000.00000000	/16	POP 332	6			2	100 ∘ 50	5		100	
140.150.0.0	11111111.11111111.00000000.00000000	/16	POP 334	7			4	100 ∘ 200 ∘ 50	10		100	

Figure 5B

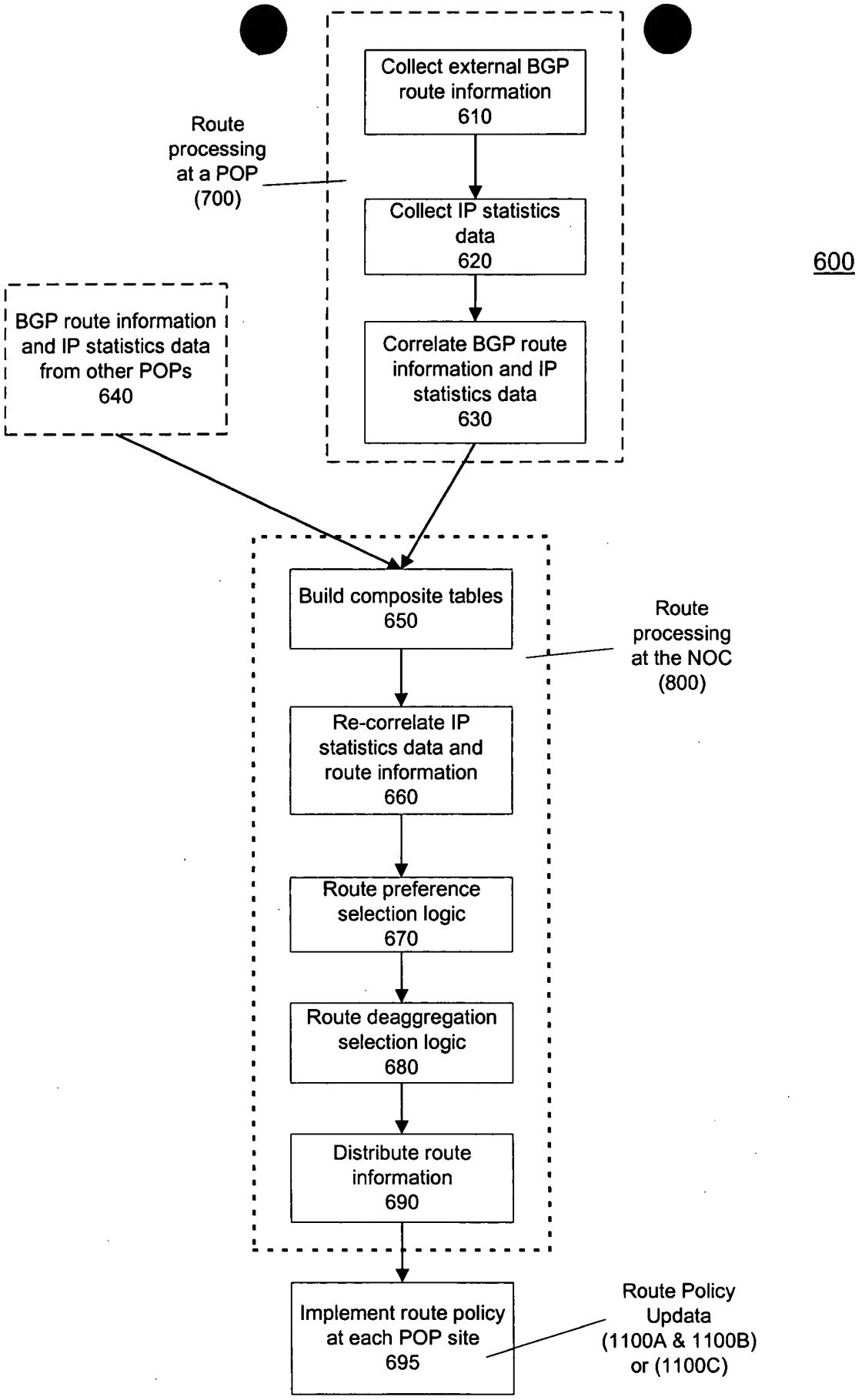

Collect external BGP route information 610
Route processing at a POP (700)
Collect IP statistics data 620
600
BGP route information and IP statistics data from other POPs 640
Correlate BGP route information and IP statistics data 630
Build composite tables 650
Route processing at the NOC (800)
Re-correlate IP statistics data and route information 660
Route preference selection logic 670
Route deaggregation selection logic 680
Distribute route information 690
Implement route policy at each POP site 695
Route Policy Updata (1100A & 1100B) or (1100C)

Figure 6

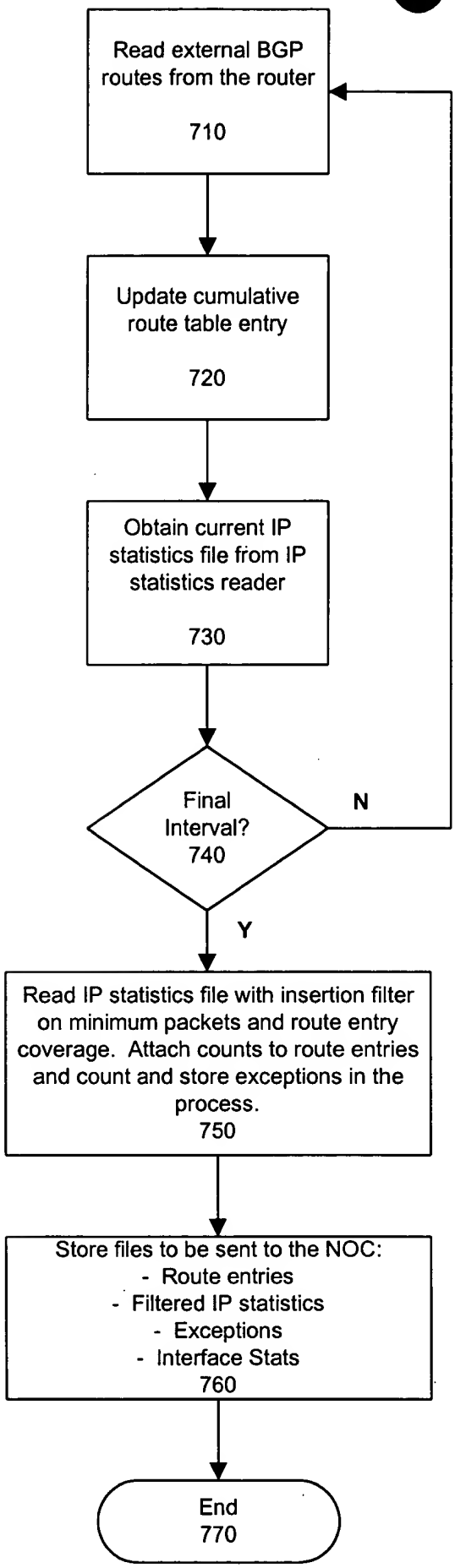

Read external BGP routes from the router
710
700
Update cumulative route table entry
720
Obtain current IP statistics file from IP statistics reader
730
Final Interval?
740
N
Y
Read IP statistics file with insertion filter on minimum packets and route entry coverage. Attach counts to route entries and count and store exceptions in the process.
750
Store files to be sent to the NOC:
- Route entries
- Filtered IP statistics
- Exceptions
- Interface Stats
760
End
770

Figure 7

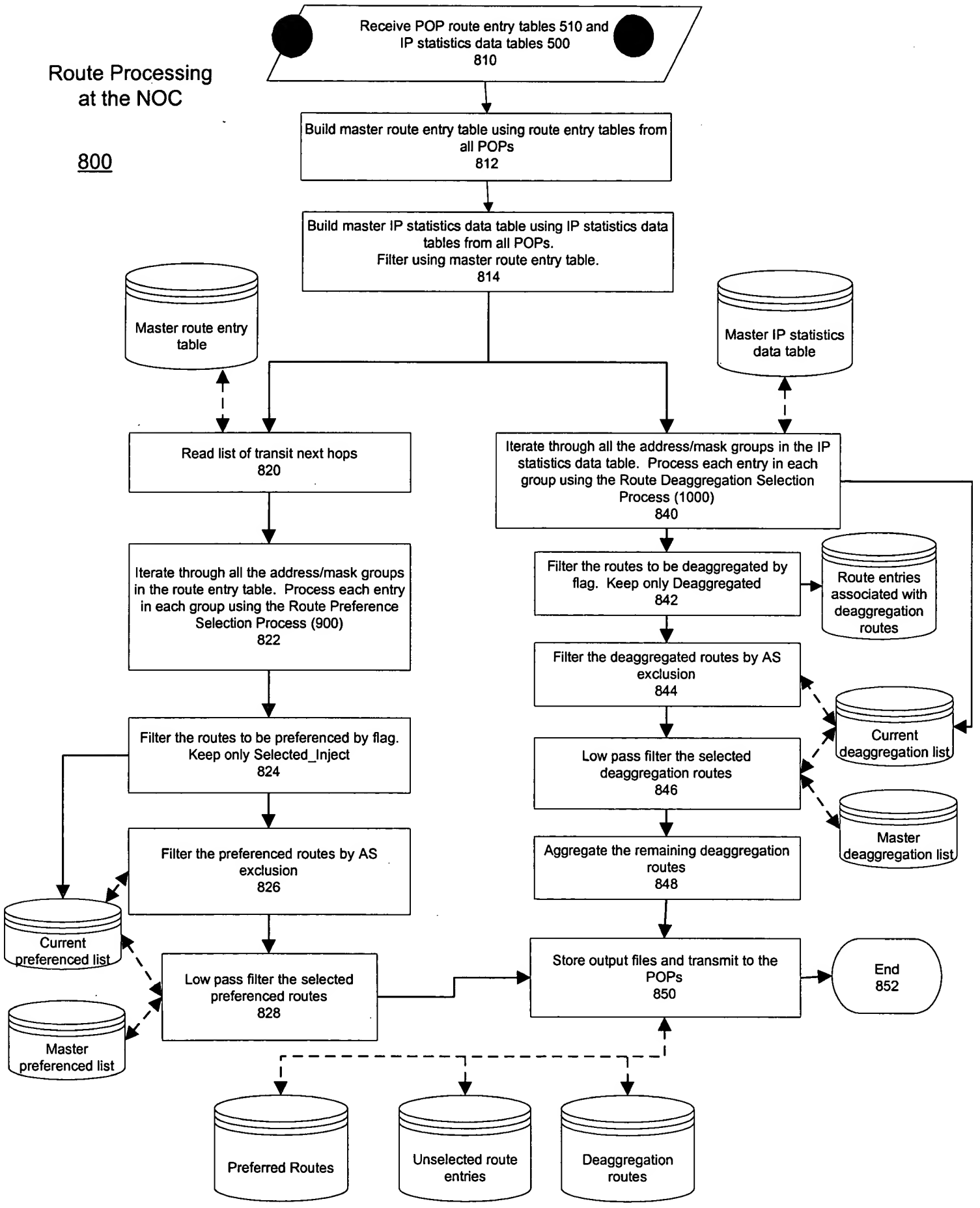

Route Processing at the NOC
800
Receive POP route entry tables 510 and IP statistics data tables 500
810
Build master route entry table using route entry tables from all POPs
812
Build master IP statistics data table using IP statistics data tables from all POPs.
Filter using master route entry table.
814
Master route entry table
Master IP statistics data table
Read list of transit next hops
820
Iterate through all the address/mask groups in the IP statistics data table. Process each entry in each group using the Route Deaggregation Selection Process (1000)
840
Iterate through all the address/mask groups in the route entry table. Process each entry in each group using the Route Preference Selection Process (900)
822
Filter the routes to be deaggregated by flag. Keep only Deaggregated
842
Route entries associated with deaggregation routes
Filter the deaggregated routes by AS exclusion
844
Current deaggregation list
Filter the routes to be preferenced by flag. Keep only Selected_Inject
824
Low pass filter the selected deaggregation routes
846
Master deaggregation list
Filter the preferenced routes by AS exclusion
826
Aggregate the remaining deaggregation routes
848
Current preferenced list
Low pass filter the selected preferenced routes
828
Store output files and transmit to the POPs
850
End
852
Master preferenced list
Preferred Routes
Unselected route entries
Deaggregation routes

Figure 8

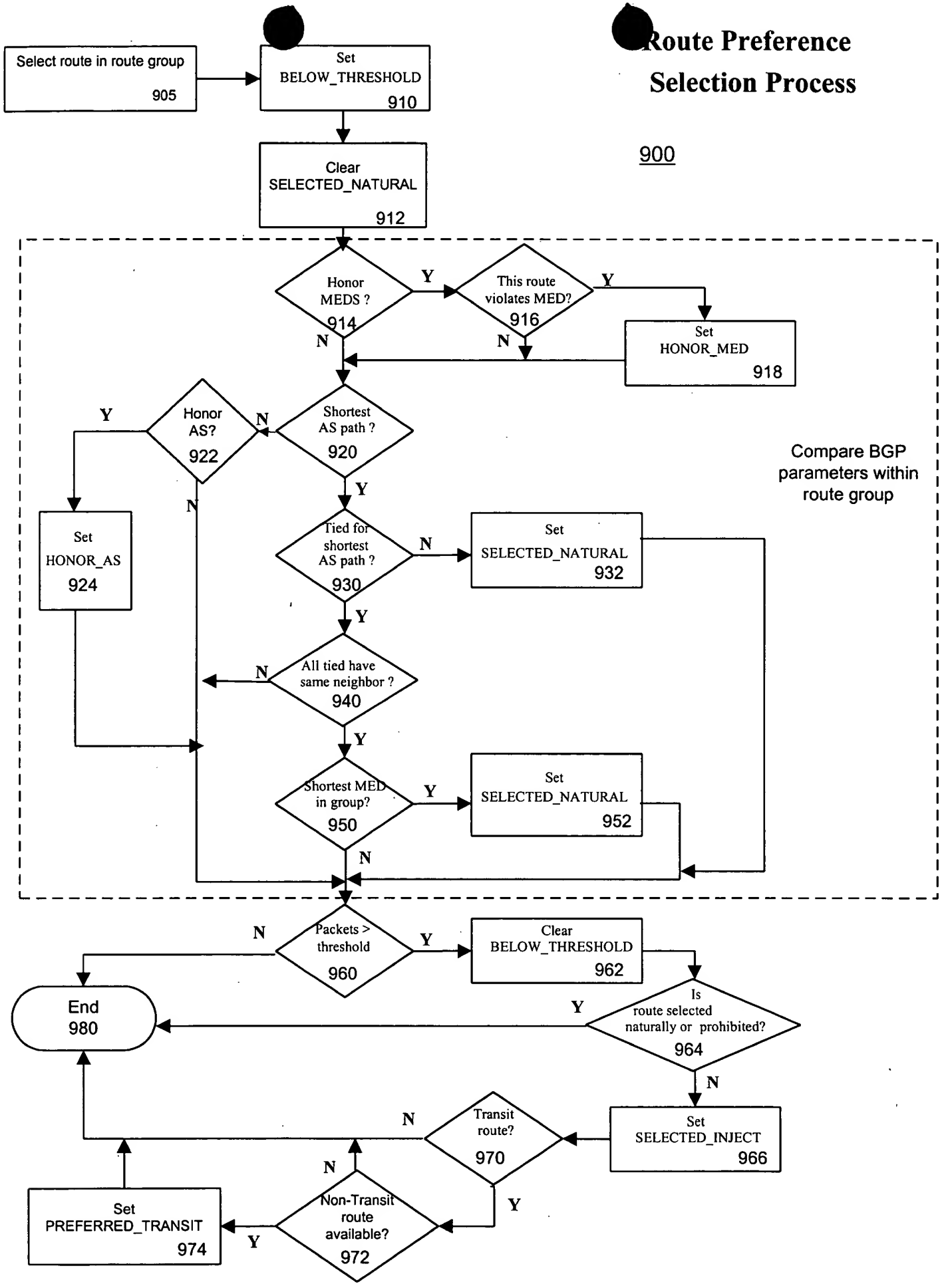

Route Preference Selection Process
900
Select route in route group
905
Set BELOW_THRESHOLD
910
Clear SELECTED_NATURAL
912
Honor MEDS ?
914
This route violates MED?
916
Set HONOR_MED
918
Honor AS?
922
Shortest AS path ?
920
Compare BGP parameters within route group
Set HONOR_AS
924
Tied for shortest AS path ?
930
Set SELECTED_NATURAL
932
All tied have same neighbor ?
940
Shortest MED in group?
950
Set SELECTED_NATURAL
952
Packets > threshold
960
Clear BELOW_THRESHOLD
962
End
980
Is route selected naturally or prohibited?
964
Set SELECTED_INJECT
966
Transit route?
970
Non-Transit route available?
972
Set PREFERRED_TRANSIT
974
Y
N

Figure 9

Route Deaggregation Selection Process

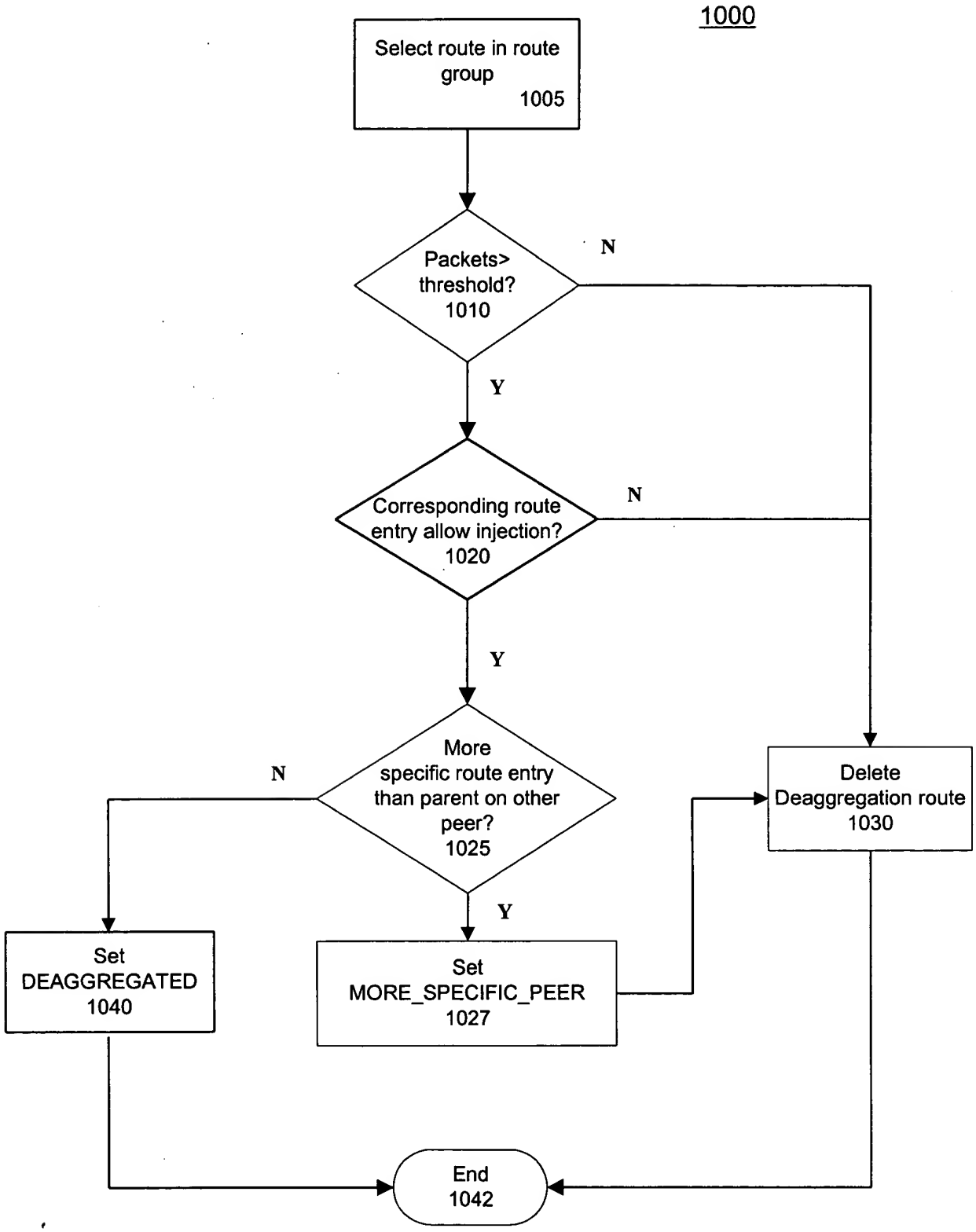


Figure 10

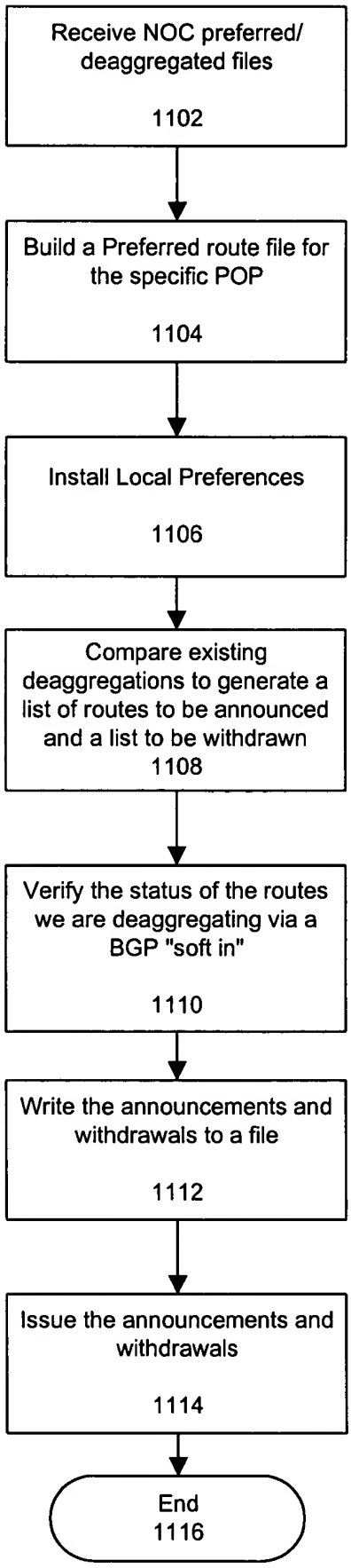

Receive NOC preferred/ deaggregated files
1102
1100A
Build a Preferred route file for the specific POP
1104
Install Local Preferences
1106
Compare existing deaggregations to generate a list of routes to be announced and a list to be withdrawn
1108
Verify the status of the routes we are deaggregating via a BGP "soft in"
1110
Write the announcements and withdrawals to a file
1112
Issue the announcements and withdrawals
1114
End
1116

Figure 11A

1100B

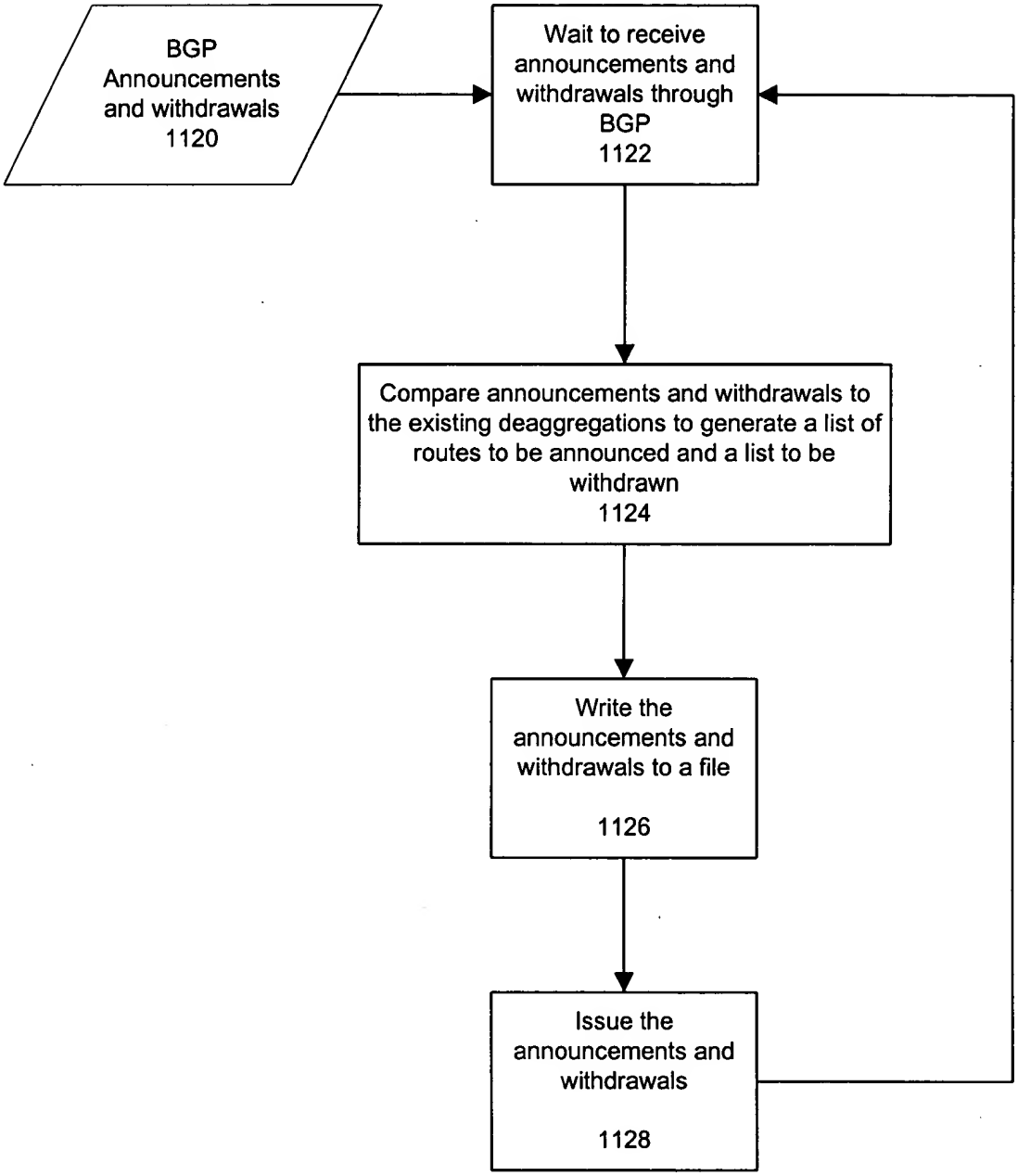


Figure 11B

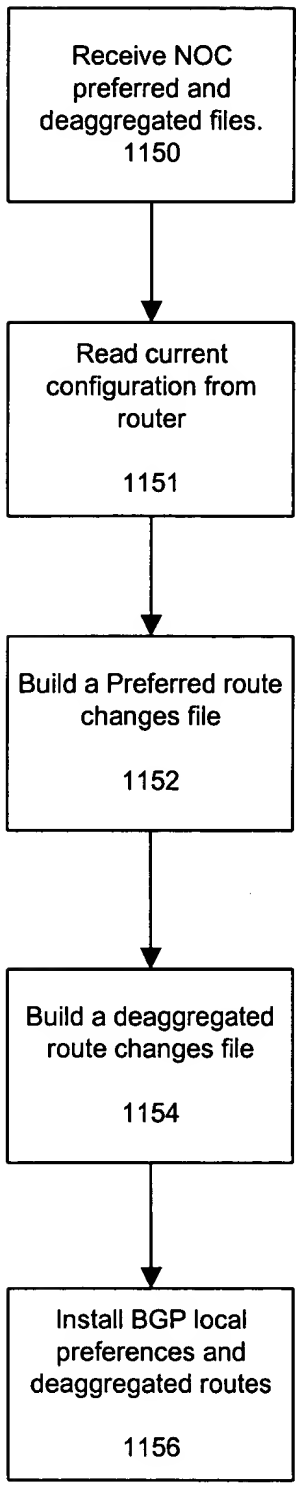

1100C
Receive NOC preferred and deaggregated files. 1150
Read current configuration from router 1151
Build a Preferred route changes file 1152
Build a deaggregated route changes file 1154
Install BGP local preferences and deaggregated routes 1156

Figure 11C

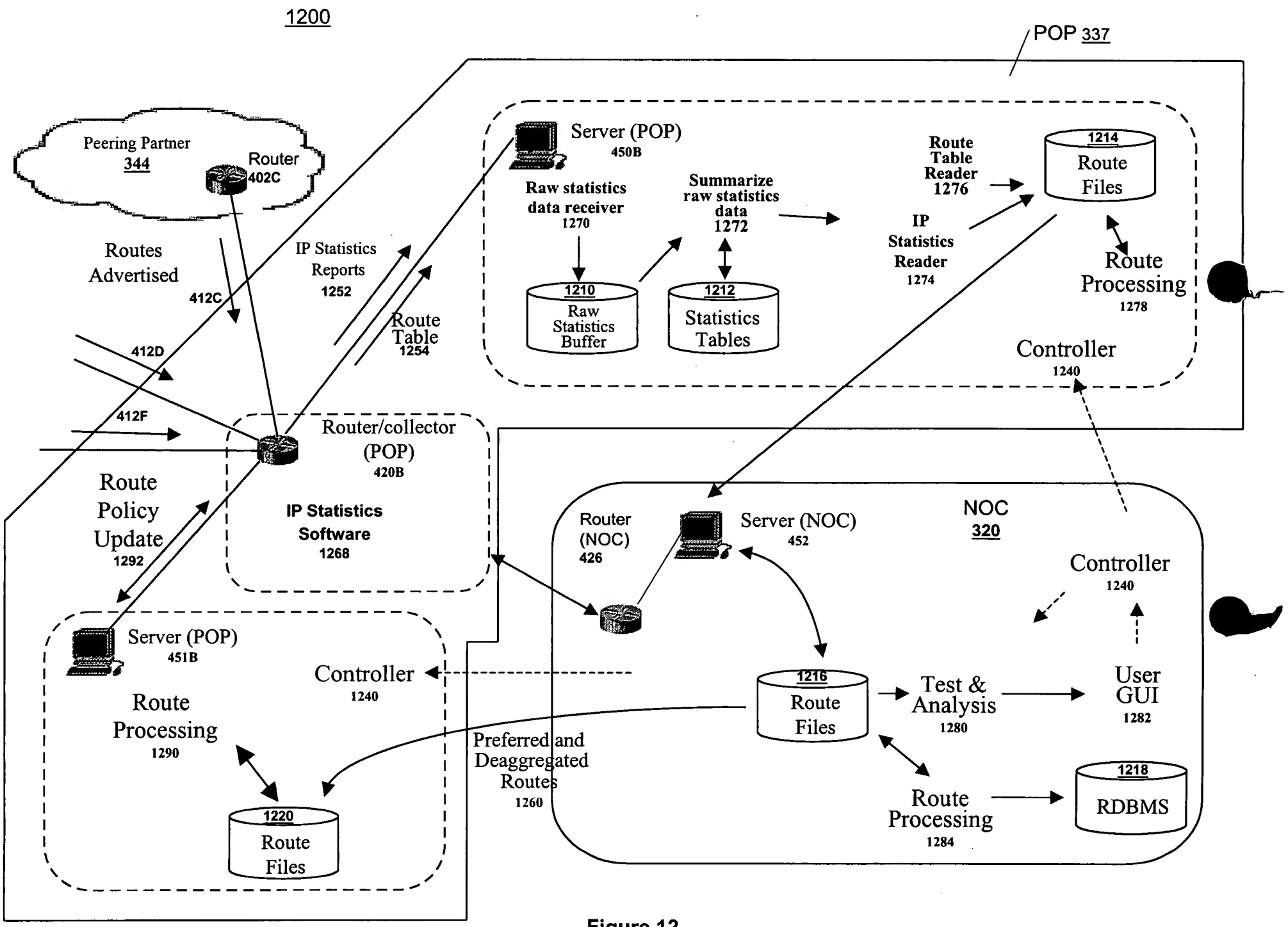

1200
POP 337
Peering Partner
344
Router
402C
Routes
Advertised
412C
412D
412F
IP Statistics
Reports
1252
Route
Table
1254
Server (POP)
450B
Raw statistics
data receiver
1270
Summarize
raw statistics
data
1272
Route
Table
Reader
1276
1214
Route
Files
IP
Statistics
Reader
1274
Route
Processing
1278
1210
Raw
Statistics
Buffer
1212
Statistics
Tables
Controller
1240
Router/collector
(POP)
420B
IP Statistics
Software
1268
Route
Policy
Update
1292
Router
(NOC)
426
Server (NOC)
452
NOC
320
Controller
1240
Server (POP)
451B
Controller
1240
Route
Processing
1290
1216
Route
Files
Test &
Analysis
1280
User
GUI
1282
Preferred and
Deaggregated
Routes
1260
1220
Route
Files
Route
Processing
1284
1218
RDBMS

Figure 12